

26 May 1969

Materiel Test Procedure 10-2-154
General Equipment Test Activity

U. S. ARMY TEST AND EVALUATION COMMAND
COMMODITY ENGINEERING TEST PROCEDURE

SHOP EQUIPMENT, GENERAL PURPOSE AND ORGANIZATION REPAIR,
VEHICULAR-MOUNTED

1. OBJECTIVE

This document provides test methods and techniques necessary to determine the technical performance and safety characteristics of vehicular mounted shop equipment, and their associated tools and equipment, as described in Qualitative Materiel Requirements (QMR's), Small Development Requirements (SDR's), and Technical Characteristics (TC's), and to determine the item's suitability for service tests.

2. BACKGROUND

A requirement exists for mobile vehicular mounted repair shops capable of repairing military engineer equipment in the field. The repair shop is required in two configurations: 1) Shop Equipment, Organizational Repair, is mounted on a modified 2 1/2 ton, 6 x 6 cargo truck chassis and is primarily intended for maintenance and repair of general mechanical equipment, 2) Shop Equipment, General-Purpose Repair is mounted on a semitrailer having a gross loaded weight of approximately 15 tons and is intended primarily for the maintenance and repair of military earth-moving and construction equipment. The semitrailer may be towed by a 6 x 6 truck-tractor.

Although minor differences exist between the particular hand tools and shop equipment supplied with each repair shop, the major equipment items are identical. Both shops have a dynamotor-welder which can operate either from an external source of alternating current electric power or can be engine driven. The truck mounted shop utilizes the truck engine. The semitrailer mounted shop is equipped with a 40 horsepower, 6 cylinder gasoline engine. When the dynamotor-welder utilizes external electric power, 40 volt direct current is generated for the welder and the external power is used for all other electrically operated equipment. When the dynamotor is engine driven, 40 volt direct current and 220 volt, 3-phase, 50/60 cycle current and, 110 volt, single-phase, 50/60 cycle power is generated. The 220 volt output may be converted to 380 or 440 volts by connecting a suitable voltage changeover panel.

Both shops also contain manual hydraulic pumps, a bench lathe, bench grinder, air compressor, and a 60,000 BTU/Hr. personnel heater. The side and rear doors of both shop bodies open to form, in combination with the tenting provided, a weather-protected work space around the two sides and rear of the van or semitrailer.

3. REQUIRED EQUIPMENT

- a. Platform Scales
- b. Steel Measuring Tape
- c. Ohmmeter

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- d. Still and Motion Picture Camera and Film.
- e. Industrial Analyzer.
- f. Sound Level Meter and Octave Band Filter.
- g. Rain Measuring Gage.
- h. Flowmeter (air flow).
- i. Recording Accelerometers.
- j. Pressure Gage.
- k. Test Samples of metal for welding, drilling, milling or grinding purposes as required.
 - l. Actual and/or Simulated Shipping and Handling Facilities (rail, marine, and seashore).
 - m. Highway Course - paved and secondary roads.
 - n. Environmental Storage Facility (-65°F to 155°F, 100 RH).
 - o. Rain Facility
 - p. DC Voltage and Current Calibration Equipment.
 - q. AC Voltage Calibration Equipment.
 - r. Indicating Clinometer.
 - s. From Munson and Perryman Test Areas of reference 4G.
 - 1) High Speed Paved Road
 - 2) Improved Gravel Road
 - 3) Belgian Block Course
 - 4) Cross-Country Course

4.

REFERENCES

- A. USATECOM Regulation 385-6, Safety Release.
- B. USATECOM Regulation 700-1, Value Engineering.
- C. USATECOM Regulation 705-4, Equipment Performance Report.
- D. AR 705-15, Operation of Materiel Under Extreme Conditions of Environment, with change 1.
- E. USAGETA Document, Human Factors Evaluation Data for General Equipment (HEDGE).
- F. HEL Standard S-1-63B, Maximum Noise Level for Army Materiel Command Equipment.
- G. Automotive Test Facilities, Materiel Test Directive, Aberdeen Proving Ground, January 1969.
- H. MTP 2-2-520, Logistics - Over-the-Shore (LOTS).
- I. MTP 2-2-613, Broadband Radio Interference Testing for Vehicles and Electrical Equipment - Non communication.
- J. MTP 2-2-800, Center of Gravity
- K. MTP 7-2-515, Air Transportability, Internal.
- L. MTP 9-2-102, Engine, Gasoline.
- M. MTP 9-2-166, Air Compressor.
- N. MTP 9-2-205, Drilling Machines.
- O. MTP 9-2-207, Lathes.
- P. MTP 9-2-212, Tool Sets.
- Q. MTP 9-2-213, Welding Equipment Machines.
- R. MTP 10-2-070, Heaters, Nonduct.
- S. MTP 10-2-500, Physical Characteristics.
- T. MTP 10-2-501, Operator Training and Familiarization.
- U. MTP 10-2-502, Durability.
- V. MTP 10-2-503, Surface Transportability (General Supplies and

Equipment

- W. MTP 10-2-505, Human Factors Evaluation.
- X. MTP 10-2-507, Maintenance Evaluation.
- Y. MTP 10-2-508, Safety.

5. SCOPE

5.1 SUMMARY

This Materiel Test Procedure describes the following tests to be performed on vehicular mounted shop equipment:

- a. Preparation for Test - A determination of the condition of the test item upon arrival, its physical characteristics and operator training and familiarization procedures.
- b. Electrical Tests - A verification of electrical continuity of all cabling, grounding, proper operation of all motor windings and a test to determine proper operation of the dynamotor-welder when operating as an engine driven generator.
- c. Equipment Performance - An evaluation to determine proper operation of major components of the repair shop.
- d. Compatibility - An evaluation to determine the suitability and ability of all components to perform intended functions without mechanically interfering with the operation of the other equipment.
- e. Electromagnetic Compatibility - An evaluation of electromagnetic interference generated by the test item.
- f. Durability - An evaluation of the operability of the repair shop after subjecting the vehicle to specified terrain conditions and the condition of the repair shop items after extended operations.
- g. Transportability - An evaluation of the test item's ability to be moved by the various means of transportation used by the Army.
- h. Cabiner Assembly Water Leakage - An evaluation of the water-tightness of the cabinet assembly under simulated rainfall.
- i. Environmental Storage - An evaluation to determine whether the test item can withstand storage under extreme conditions of heat, cold, and humidity.
- j. Safety - An evaluation to determine whether the test item contains any hazards.
- k. Maintainability and Reliability Evaluation - That portion of the test which is concerned with the following: verification and appraisal of failures; determination and appraisal of maintenance characteristics and requirements; appraisal of design-for maintainability; appraisal of the maintenance test package; and, calculation of indicators which express the effects of the preceding aspects.
- l. Human Factors Evaluation - An evaluation of the man-item relationship during installation, operation and maintenance of the test item, to include the noise level generated by the equipment, the design deficiencies, and transportability characteristics.
- m. Value Analysis - An evaluation to determine whether the test item contains any unnecessary costly, or nice-to-have features.

5.2 LIMITATIONS

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The primary purpose of this MTP is to provide procedures for determining the technical performance of the repair shop as a system. For that reason, detailed engineering evaluations of the repair shop components are not included in this document. These procedures may be found in the following MTP's:

- a. Engine, Gasoline, 9-2-102
- b. Air Compressor, 9-2-166
- c. Drilling Machines, 9-2-205
- d. Lathes, 9-2-207
- e. Tool Sets, 9-2-212
- f. Welding Equipment Machines, 9-2-213
- g. Heaters, Non-duct, 10-2-070

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Initial Inspection

Upon receipt of the test item at the test site, the test item shall be subjected to the following procedures:

a. Visually inspect the assembled test item and, if applicable, the blocking used for rail shipment, and record the following:

- 1) Evidence of damage or deterioration to both the test item and blocking.

NOTE: Make use of photographs, diagrams, and narration to document the condition of the test item.

- 2) Identification markings, including:

- a) Name of manufacturer
- b) Date of manufacture
- c) Other pertinent markings.

b. Unload the various repair shop components, visually inspect each of the components, and record the following:

NOTE: Make use of photographs, diagrams, and narration to document the condition of the test item components.

- 1) Evidence of defects in:

- a) Manufacturing
- b) Material
- c) Workmanship

- 2) Evidence of damage

- 3) Evidence of deterioration
- 4) Component identification markings and instructions, including:
 - a) Identification, name, model and serial number
 - b) Caution instructions
 - c) Service instructions
 - d) Manufacturer's name and date of manufacture
- 5) Evidence of shortages

6.1.2 Physical Characteristics

Determine and record the physical characteristics of the repair shop according to the applicable portions of MTP 10-2-500 and the following:

- a. For the assembled test item:
 - 1) Weight.
 - 2) Length, width, and height.
 - 3) Cubage.
 - 4) Center of gravity as described in MTP 2-2-800.
 - 5) Dimensions of all access openings, storage compartments, and material for operator or passenger use.
- b. For the test item major components:
 - 1) Weight
 - 2) Length, width, and height
 - 3) Cubage

6.1.3 Operator Training and Familiarization

Test personnel shall be oriented in all aspects of the test item as described in the applicable section of MTP 10-2-501 and the following:

a. All members of the test team shall receive a review of safety precautions listed in the technical manuals or developed from previous test experience. The review will, as a minimum, include hazards related to the following:

- 1) Vehicle and cabinet assembly
- 2) Air compressor
- 3) Dynamotor-welder
- 4) Grinding machine
- 5) Lathe
- 6) Personnel heater
- 7) Miscellaneous powered and hand tools
- 8) Handling during transport operations

b. Test personnel will be instructed in the capabilities of the test item and in the objectives and procedures of the test.

c. The set-up, operating, and maintenance procedures for all machines will be presented. Methods of securing the components for transport will be

reviewed. The technical manuals will be made available for study.

d. Operators will undergo simulated operations with the test item. The progress of each operator will be reviewed to assess the degree of proficiency attained.

e. Record the amount of time and type of training or familiarization required for each operator.

f. Record personnel data as described in the applicable sections of MTP 10-2-501.

g. Record any unusual training or safety problems.

6.1.4 Preparation

Prepare the repair shop for test as follows:

a. Set-up the components of the test item in a normal operating arrangement as described in the manufacturer's instructions or draft technical manual.

b. Remove all protective material and preservatives.

c. Lubricate all components of the test item following the procedures of the applicable lubrication order.

d. Calibrate the voltage and current meters on the dynamotor-welder.

6.2 TEST CONDUCT

NOTE: 1. All equipment failures shall be reported in accordance with USATECOM Regulation 705-4.

2. Before operating the test item, the following precautions shall be taken:

- a) Brakes set and wheel chocks in place.
- b) Body of shop and generator properly grounded.
- c) Adequate ventilation for engine exhaust.
- d) All clutch levers in neutral or disengaged position.
- e) No fuel leakage or vapors present.
- f) All electrical circuits "off" before connecting external power or starting engine.
- g) Personnel clear of machinery before starting engine.

3. At all times during the test, normal safety precautions such as the following shall be observed:

- a) Refuel the engine only when turned off.
- b) Disconnect external power or turn off engine before removing voltage changeover panel.
- c) Do not smoke while servicing the batteries.
- d) Operate shop set only with proper ventilation.
- e) Keep loose material and clothing away from rotating machinery.
- f) Bleed the air reservoir before performing maintenance on air compressor or air lines.

- g) Ensure that power is off before performing any maintenance on electrical circuits or machinery.
- h) Utilize crane with sufficient load rating when lifting shop set and do not allow shop set to swing back and forth when suspended in the air.

6.2.1 Electrical Tests

6.2.1.1 Continuity

a. Determine that all electrical cables supplied with the test item are continuous by checking for continuity with an ohmmeter and record the presence and location, as applicable of the following:

- 1) Short circuits
- 2) Open circuits
- 3) Incorrect wiring
- 4) Defects in materials, i.e., frayed insulation

b. Check each electrical machine motor winding for proper resistance. Record any short circuit, open circuit, or incorrect resistance.

6.2.1.2 Power Requirements

a. Set up the repair shop to operate from a 220 volt, 60 cycle, 3 phase source of electrical power and set selector switch to "OFF".

b. Install an industrial analyzer in the cable between the source of power and the repair shop.

c. Turn off all electrical equipment in the test item.

d. Set selector switch to "CITY".

e. Start the dynamotor-welder and record the following for each power line with no load:

- 1) Voltage
- 2) Current
- 3) Wattage
- 4) Power factor

f. Repeat step e while a qualified arc-welder makes a weld using the maximum current setting.

g. Turn the dynamotor welder off.

h. Repeat step e for each electrical machine under the following conditions:

- 1) Without load
- 2) With load

i. Verify that the specified power is available to all electrical outlets.

6.2.1.3 Dynamotor Power Output

- a. Set up the dynamotor-welder for engine driven operation at 220 volts output.
- b. Install an industrial analyzer (or equivalent instruments capable of measuring voltage, current, power factor, and wattage) in the cable between the dynamotor-welder and the control panel.
- c. Turn all electrical equipment off. Start the engine and allow it to warm up for the specified time.
- d. Turn the selector switch to "GEN" and start the dynamotor-welder.
- e. Set the frequency switch to 60 cycles and check the frequency meter reading. If the reading is not 60 cycles, adjust the engine throttle to give a 60 cycle reading.
- f. Measure and record the maximum and minimum voltages obtainable with the voltage adjustment control at the power output receptacle. Set the voltage to 220 volts.
- g. Place a piece of stock in the bench lathe and start the motors on the bench lathe and grinder, and turn on all working lights.
- h. Measure and record the generator output voltage and readjust to 220 volts, if necessary.
- i. Apply a load to the lathe and record the following:
 - 1) Voltage
 - 2) Current
 - 3) Power factor
 - 4) Wattage
- j. While the lathe is in operation, turn the circuit breaker on and verify the presence of 110 or 200 volt power at the corresponding receptacles. Measure and record the voltage at each outlet.
- k. Repeat steps i and j while operating the grinder under load.
- l. Repeat steps i and j with the air compressor in operation.
- m. Repeat steps i and j while operating the lathe, grinder, and compressor simultaneously.
- n. Repeat steps f through i while a qualified arc-welder makes a weld using maximum weld current.
- o. Turn off all electrical equipment and stop the engine.
- p. Install the 380 volt change panel and record any difficulties.
- q. Repeat step c through o except set the voltage to 380 volts in steps f and h.
- r. Repeat step p and q using the 440 volt change panel.

6.2.2 Equipment Performance

Evaluate the performance of major shop equipment as follows:

6.2.2.1 Dynamotor-Welder

Perform the following:

- a. Set up the dynamotor-welder for engine driven operation at 220 volts output.

- b. Turn all electrical equipment off and turn the welder fine adjustment control to minimum.
- c. Start the engine and allow it to warm up for the specified time and record the time.
- d. Turn the selector switch to "GEN", start the dynamotor-welder and record the actual turn on time and the running time meter recording.
- e. Set the frequency switch to 60 cycles and check the frequency meter reading. If the reading is not 60 cycles, adjust the engine throttle to give a 60 cycle reading.
- f. Have a qualified arc-welder operator deposit 3 linear feet of weld on test materials using straight polarity at the following outputs:
 - 1) Minimum current
 - 2) Intermediate current
 - 3) Maximum current.
- g. Record the following:
 - 1) DC voltage and current readings during welding
 - 2) Failure of welder to maintain a steady arc
 - 3) Quality of weld
 - 4) Difficulties in set up or operation of the dynamotor-welder
- h. Repeat steps g and h using reverse polarity.
- i. Turn all electrical equipment off and stop the engine. Record the actual time and the running time meter reading.

6.2.2.2 Personnel Heater

Operate the heater continuously for at least 15 minutes. Record the following:

- a. Malfunctioning of deflectors or fuel supply line.
- b. Incorrect thermostat operation.
- c. Smoking, sooting, or back draft.
- d. Entrance of fuel vapors or exhaust gases into the shop interior
- e. Adequacy of heat output

6.2.2.3 Bench Lathe

- a. Operate the bench lathe for a minimum of 15 minutes each for at least three different test materials and each of the test items' capabilities.
- b. During the operation, observe the lathe for the following.
 - 1) Proper concentricity of the chuck with dead center
 - 2) Smoothness of operation
 - 3) Adequacy of controls and indicators
 - 4) Proper functioning of stops
 - 5) Overall suitability of lathe
- c. Record any malfunctions or improper operation.

6.2.2.4 Bench Grinder

- a. Operate the bench grinder for a minimum of 15 minutes using at least three different test materials.
- b. During the operation, observe the grinder for the following:
 - 1) Wobble in the grinder wheels.
 - 2) Adequacy of controls and indicators.
 - 3) Suitability of grinder.
- c. Record any malfunctions or improper operation.

6.2.2.5 Air Compressor

- a. Attach a pressure gage to the air compressor outlet so that no air flow will occur.
- b. Operate the compressor and record the pressure readings on both the test gage and the system pressure gage.
- c. Turn the compressor off. Connect the flowmeter and the pressure gage so that maximum air flow is possible at maximum output.
- d. Operate the compressor at maximum output. Record the following:
 - 1) Pressure reading on test gage
 - 2) Pressure reading on system gage
 - 3) Flowmeter reading
- e. Record evidence of leakage in the system.

6.2.2.6 Miscellaneous Tools

Determine the suitability of electrically and pneumatically driven hand tools, and manually operated hydraulic pump(s) by performing the operation they were designed to do, on each type of appropriate material when applicable, and record the following:

- a. Smoothness of operation
- b. Adequacy of performance
- c. Adequacy of controls and indicators, if applicable
- d. Ease of handling
- e. Difficulties encountered using tool
- f. Malfunctions, if any

6.2.3 Compatibility

- a. Determine and record whether the operation of any component interferes with the operation of another component when operating simultaneously.
- b. Determine and record whether the components are designed and located so that they can be operated as intended.

6.2.4 Electromagnetic Compatibility

Electromagnetic compatibility shall be determined as described in MTP 2-2-613. The operation of the repair shop during this test shall be as follows:

- a. Equipment shall be operated above 40°F.
- b. All machinery shall be properly lubricated as described in the appropriate lubrication order.
- c. All machines will be operated at maximum power.

6.2.5 Durability Tests

6.2.5.1 Repair Shop Durability Tests

NOTE: When applicable these tests shall be conducted in conjunction with the transportability test of paragraph 6.2.6.

- a. Prepare the repair shop for testing as follows:

- 1) Install all components of the repair shop and secure for transport in accordance with instructions.
- 2) Attach and record the location of recording accelerometers to the repair shop so as to obtain shock readings along the longitudinal, transverse, and vertical axes.

- b. Determine the durability of the test item as described in the applicable sections of MTP 10-2-502.

6.2.5.2 Machine Durability

Perform the following on all repair shop power operated machines:

- a. Setup each applicable machine for normal operation.
- b. Apply power to and run each machine continuously for 8 hours at the machines maximum rate.
- c. Perform normal operations, for a minimum of 15 continuous minutes each hour, with all controls and adjustments cycled through their range of operation.

NOTE: For machines capable of performing more than one operation, perform each operation a minimum of one time during this 8 hour test period.

- d. At the completion of the 8 hour test period perform the following on each machine:

- 1) Visually examine the test machine and record:
 - a) Evidence of accelerated wear
 - b) Potential equipment features
 - c) Damage to components, material, or finish
 - d) Evidence and location of overheating

2) Record, as applicable:

- a) Loss of adjustments
- b) Loosening of hardware, or components
- c) Drive mechanism slippage
- d) Maintenance requirements

3) Measure and record the direct current resistance of each motor winding.

NOTE: Measure the resistance within 15 minutes after the end of the 8 hour test period.

e. For each defect revealed in step d, record the nature of the defect, location of the defect, cause of defect (if known) and recommended remedy.

NOTE: In the event of equipment failure during the durability test, the procedures of the maintenance section will be performed and the durability test rerun following repair of the test item.

6.2.6 Transportability

6.2.6.1 Preparation for Test

Prepare the repair shops for transport as described in paragraph

6.2.5.1.

6.2.6.2 Surface Transportability Tests

Perform the rail, highway and ship surface transportability tests as described in the applicable sections of MTP 10-2-503 with the following modifications:

a. Highway Transportability - Drive the loaded carrier, at speeds of 45 mph depending on safe field speed, a minimum of five miles over each of the following types of courses:

- 1) Paved highway
- 2) Improved gravel
- 3) Cobblestone road
- 4) Loose rock road
- 5) Washboard road (minimum 2 inch washboard)

b. Ship Test - The period of the simulated ship pitch and roll, shall be 30 seconds.

c. At the completion of each phase of testing, perform the following:

- 1) Inspect the repair shop for damages.
- 2) Repeat the equipment performance evaluation of paragraph 6.2.2.
- 3) Record damages to the repair shop and/or degradation in performance if any.

6.2.6.3 Air Transportability

NOTE: This sub-test shall be conducted by TOE type units or by personnel of appropriate airborne MOS.

- a. Determine and record the internal air transportability of the test item as described in the applicable sections of MTP 7-2-515.
- b. At the completion of step a perform the procedures of paragraph 6.2.6.2.c.

6.2.6.4 Logistics-Over-The-Shore (LOTS)

Perform the applicable sections of MTP 2-2-520 and the following:

- a. Load the test item and suitable towing vehicle aboard a landing craft from a ship anchored offshore using normal ships handling equipment, couple the test item to the towing vehicle, and record the following:

- 1) Sea state and duration
- 2) Wind direction and speed
- 3) Equipment used for loading
- 4) Difficulties encountered loading or coupling
- 5) Materials used for securing
- 6) Damage to test item or towing vehicle

- b. The test item shall be transported to the shoreline, off-loaded and towed through sea and surf up to 20 inches, including vehicle-sinkage depth and wave height for a minimum of 15 minutes. The test item will then be towed over the sand to a point not less than 2 miles from the shoreline, disassembled, and inspected for damage or water penetration. Determine the optimum tire pressures for both the test item and the towing vehicle and record the following:

- 1) Water depth.
- 2) Difficulties in towing.
- 3) Test item and towing vehicle tire pressures.
- 4) Any deficiencies in operation or damage to the components of the test item.

- c. The test item shall be secured for transport, towed to the shoreline and reloaded onto the landing craft by both driving and backing into the craft. Any difficulties encountered in reloading or damage to the test item will be recorded.

- d. At the completion of the test, repeat the procedures of step 6.2.6.2.c.

6.2.7 Cabinet Assembly Water Leakage

6.2.7.1 Preparation for Test

Prepare the repair shop for test as described in 6.2.5.1.

6.2.7.2 Test Procedure

a. The repair shop shall be subjected to simulated rainfall at the rate of 3 inches per hour for not less than one hour. The direction of rainfall shall include all angles from vertical to 45 degrees from vertical. Each of the 4 sides shall be exposed for at least 15 minutes with each side exposure including exposure of the top.

b. At the completion of the test, the cabinet or cover shall be removed and the following observations made and recorded:

- 1) Amount of water present in the shop interior.
- 2) Damage to equipment, tools, stored materials, etc. due to water penetration or moisture contamination.
- 3) Location and reason for leakage, if known.

6.2.8 Environmental Storage

6.2.8.1 Preparation for Test

Prepare the repair shop for test as described in 6.2.5.1, step a.

6.2.8.2 High Temperature Storage

a. Store the test item for 48 hours in a test chamber producing an air temperature of 155°F at an absolute humidity of 13 grains/ft.³ without benefit of solar radiation and with negligible air movement.

b. At the completion of the storage period, after the test item has returned to ambient temperature, perform the following:

- 1) Disassemble the test item and record any damage or deterioration to the test item components.
- 2) Allow the test item to return to normal operating conditions and determine degradation in performance, if any, due the storage test by repeating paragraph 6.2.2.

6.2.8.3 Low Temperature Storage

a. Store the test item for 48 hours in a test chamber producing an air temperature of -65°F without benefit of solar radiation and with negligible air movement.

b. Repeat the procedures of paragraph 6.2.8.2.b.

6.2.8.4 Humidity Test

a. Store the test item (packed for storage) for 48 hours in a test chamber producing an air temperature of 85°F at a relative humidity of 100%.

b. Repeat the procedures of paragraph 6.2.8.2.b.

6.2.9 Safety

Determine the safety characteristics of the repair shop as described in the applicable sections of MTP 10-2-508 and as follows:

a. Throughout the test period, test personnel shall observe and record the following:

- 1) Deviations from normal safety precautions during operation of the repair shop.
- 2) Special precautions required for operating and maintaining the test items.
- 3) Need for eye protection, safety switches and guards in stationary power tools.
- 4) Any condition that might present a safety hazard, cause of hazard, and steps taken to alleviate the hazard.

b. Check for ground voltages in machine frames, etc.

6.2.10 Maintainability and Reliability Evaluation

Evaluate the maintenance-related factors of the test item as described in MTP 10-2-507 with emphasis on the following:

- a. Organizational (O), Direct Support (F), and General Support (H) Maintenance requirements.
- b. Operator through General Support Maintenance Literature.
 - c. Repair parts.
 - d. Tools.
 - e. Test and handling equipment.
 - f. Calibration and maintenance facilities.
 - g. Personnel skill requirements.
 - h. Maintainability
 - i. Reliability.
 - j. Availability.

6.2.11 Human Factors Evaluation

NOTE: This sub-test is conducted to evaluate the man-item relationship during normal shop use and to compare the test item with a standard or control shop as to operational characteristics; the man-item relationship, such as ease of assembly, dismantling, operating, maintaining, and transporting and to determine whether the repair shops are safe in operation from the standpoint of electrical transmission. Where test standards do not exist, suitability of the shops will be based upon the observations and comments of the test supervisory personnel. Comparisons between the characteristics of the test and standard shops will be considered in determining the suitability of the repair shops. Criteria for acceptable noise level will be in accordance with standard noise testing procedures in appropriate QMR, SDR, or other developmental criteria.

Human factors evaluation shall be conducted as described in the applicable section of MTP 10-2-505 and the following:

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a. Task/item checklists should be developed which detail the human factors design criteria for each major piece of equipment and the repair shop as a whole. These checklists will provide for test supervisory personnel comments regarding the degree to which human factors considerations have been included in the design of the test item. Detailed criteria and human factors considerations for each task may be developed from Human Factors Evaluation Data for General Equipment (HEDGE) of November, 1967 and will include evaluation of the following:

- 1) Maintenance and Repair Equipment (Tool Kits, Portable Power Tools, Hand-held Equipment, etc.):
 - a) Operability
 - b) Maintainability
 - c) Transportability
- 2) Production/Modification Equipment (Heaters, Lathes, Drill Presses, Welders, Motor Generators, etc.):
 - a) Operability
 - b) Maintainability
 - c) Transportability
- 3) Repair Shop as a System:
 - a) Operability
 - b) Maintainability
 - c) Transportability

b. Measure and record the noise level of a fully operating repair shop (all machines operating) at each operator station using the equipment of reference 4F (HEL-Std S-1-61B). Record any adverse effects on test personnel due to noise.

c. Throughout the test observe and record comfort of personnel using component, accessibility of components, and ease of assembling, dismantling, and transporting the test item.

d. Record comfort of environment inside the trailer and the tent attached to it.

e. Record difficulties arising from man-item relationships and action taken to overcome them.

6.2.12 Value Analysis

During equipment set-up, operation, and maintenance of the repair shops, the test personnel shall observe and record any costly, non-functional, or nice-to-have design features that can be eliminated, modified, or simplified without compromising the technical characteristics and safety of the repair shops.

6.3 TEST DATA

6.3.1 Preparation For Test

6.3.1.1 Initial Inspection

Record the following:

a. For the assembled test item:

- 1) Evidence of damage or deterioration
- 2) Identification markings:
 - a) Name of manufacturer
 - b) Date of manufacture
 - c) Other pertinent markings

b. For each component

- 1) Evidence of defects in:
 - a) Manufacturing
 - b) Material
 - c) Workmanship
- 2) Evidence of deterioration
- 3) Evidence of damage
- 4) Identification markings:
 - a) Identification, name, and serial number
 - b) Caution instructions
 - c) Service instructions
 - d) Manufacturer's name and date of manufacture
- 5) Evidence of shortage

6.3.1.2 Physical Characteristics

Record the following:

a. For the assembled test item:

- 1) Weight, in pounds
- 2) Overall dimension, in feet and inches, of:
 - a) Length
 - b) Width
 - c) Height
- 3) Cubage, in ft³.
- 4) Center of gravity
- 5) Dimensions, in feet and inches, of:

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- a) Access openings
- b) Storage compartments
- c) Material for operator or passenger use

b. For the test item major components:

- 1) Weight, in pounds
- 2) Length, width, and height in feet and inches
- 3) Cubage

6.3.1.3 Operator Training and Familiarization

Record the following:

- a. Degree of skill and special skills utilized by personnel to become proficient in performing their tasks.
- b. Time and type of training or familiarization required for each operator.
- c. Personnel data as described in the applicable section of MTP 10-2-501.
- d. Any unusual training or safety problems.

6.3.1.4 Preparation

Record the results of the calibration of the voltage and current meters on the dynamotor-welder.

6.3.2 Test Conduct

6.3.2.1 Electrical Tests

6.3.2.1.1 Continuity -

Record the following:

- a. Cable identification markings, if applicable
- b. Defects in cables:
 - 1) Shorts
 - 2) Opens
 - 3) Incorrect wiring
 - 4) Defects in materials, i.e., frayed insulation
- c. Motor resistance readings in ohms.
- d. Defects in motor windings (short circuit, open circuit, or incorrect resistance).

6.3.2.1.2 Power Requirements -

Record the following:

a. For each power line:

1) For each load condition:

- a) Number and type machine(s) on line
- b) Type load (motor on, operating under load)

- 2) Voltage in volts
- 3) Current in amps
- 4) Wattage, in watts
- 5) Power factor

b. Lack of power at any receptacle.

6.3.2.1.3 Dynamotor Power Output -

Record the following for each voltage change panel:

- a. Voltage change panel used (220, 380, 440)
- b. Welder operating condition (no load, maximum load)
- c. Voltage regulator range:

- 1) Maximum voltage obtainable, in volts
- 2) Minimum voltage obtainable, in volts

d. For each power line:

1) For each load condition:

- a) Number and type machine(s) on line
- b) Type load (motor on, operating under load)

- 2) Voltage, in volts
- 3) Current, in amps
- 4) Wattage, in watts
- 5) Power factor

e. Voltage at each receptacle

6.3.2.2 Equipment Performance

6.3.2.2.1 Dynamotor-Welder -

Record the following:

- a. Engine warm up time in minutes.
- b. Actual time dynamometer-welder turned on.
- c. Running time meter reading at turn on.
- d. During welding operations:
 - 1) Polarity used, normal or reverse.

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- 2) DC voltage reading, in volts.
- 3) DC current reading, in amps.
- 4) Failure of welder to maintain a steady arc.
- 5) Quality of weld.
- 6) Difficulties in set up or operation of the dynamotor-welder and action taken to overcome difficulties.

- e. Actual time of turn off.
- f. Running time meter reading at turn off.

6.3.2.2.2 Personnel Heater -

Record the following:

- a. Malfunctioning of deflectors or fuel supply line.
- b. Incorrect thermostat operation.
- c. Smoking, sooting, or back draft.
- d. Entrance of fuel vapors or exhaust gases into the shop interior.
- e. Adequacy of heat output.
- f. Any other difficulties, including a description of the effect of the difficulty and action taken.
- g. Total time operated

6.3.2.2.3 Bench Lathe -

Record the following:

- a. Material used
- b. Operation performance (ream, thread, cut, etc.)
- c. Smoothness of operation.
- d. Adequacy of controls and indicators.
- e. Concentricity of chuck with dead center.
- f. Overall suitability of lathe and work.
- g. Proper functioning of stops.
- h. Malfunctions, their effect and cause, and action taken to correct malfunction.

6.3.2.2.4 Bench Grinder -

Record the following:

- a. Material used.
- b. Excessive wobble in grinder wheels.
- c. Adequacy of controls and indicators.
- d. Overall suitability of grinder and work.
- e. Equipment malfunctions, their effect and cause, and action taken to correct malfunction.

6.3.2.2.5 Air Compressor -

Record the following:

- a. Pressure reading of test gage at no flow, in psi.
- b. Pressure reading of system gage at no flow, in psi.
- c. Pressure reading of test gage at maximum flow, in psi.
- d. Pressure reading of system gage at maximum glow, in psi.
- e. Flowmeter reading
- f. Evidence of leakage in system

6.3.2.2.6 Miscellaneous Tools -

Record the following for each tool and operation, as applicable:

- a. Item being tested (hand drill, lifting jack, etc.)
- b. Operation performed (drill 1/2" hole, tap 6:32 thread, etc.)
- c. Test material used (wood, aluminum, etc.)
- d. Smoothness of operation
- e. Adequacy of performance
- f. Adequacy of controls and indicators
- g. Ease of handling
- h. Difficulties encountered using tool
- i. Malfunctions, if any

6.3.2.3 Compatibility

Record the following:

- a. Interference of any component with the operation of other components being operated simultaneously.
- b. Adequacy of design and location of components.

6.3.2.4 Electromagnet Compatibility

Record the following:

- a. Data collected as described in MTP 2-2-613.
- b. Operating conditions.

6.3.2.5 Durability Tests

6.3.2.5.1 Repair Shop Durability Tests -

Record the following:

- a. Location of recording accelerometers.
- b. Data collected as described in the applicable sections of MTP

10-2-502.

6.3.2.5.2 Machine Durability -

Record the following for each machine tested:

- a. Machine under test (lathe, sander, etc.)
- b. Operation performed

c. Any equipment failures during the (8) hour test, and other maintenance data such as operating time, MTBF, MTTR, parts used, downtime, etc.

d. On completion of the test item run:

- 1) Evidence of accelerated wear
- 2) Potential equipment failures
- 3) Damage to components, material or finish
- 4) Location of overheating
- 5) Loss of adjustments
- 6) Loosening of hardware or components
- 7) Drive mechanism slippage
- 8) For each motor:

- a) Motor under test
- b) D.C. resistance of each winding

6.3.2.6 Transportability

6.3.2.6.1 Preparation for Test -

Record the location of recording accelerometers.

6.3.2.6.2 Surface Transportability Test -

Record the following:

- a. Data collected as described in the applicable sections of MTP 10-2-503.
- b. Damages to repair shop.
- c. Performance data as described in paragraph 6.2.2.

6.3.2.6.3 Air Transportability -

Record the following:

- a. Data collected as described in the applicable section of MTP 7-2-515.
- b. Damages to repair shop.
- c. Performance data as described in paragraph 6.2.2.

6.3.2.6.4 Logistics-Over-the-Shore (LOTS)

Record the following:

- a. Data collected as described in the applicable sections of MTP 2-2-520.
- b. During loading:
 - 1) Sea State (1, 5, etc.) and duration, in seconds
 - 2) Wind direction and speed, in knots
 - 3) Equipment used for loading
 - 4) Difficulties encountered loading or coupling

- 5) Materials used for securing
- 6) Damage to test item or towing vehicle
- c. During off-loading and towing operations:
 - 1) Water depth, in inches.
 - 2) Difficulties in towing.
 - 3) Test item and towing vehicle tire pressure, in psi.
 - 4) Any deficiencies in operation or damage to the components of the test item.
- d. During reloading operations:
 - 1) Difficulties encountered reloading
 - 2) Damage to the test item
- e. Performance data as described in paragraph 6.2.2.

6.3.2.7 Cabinet Assembly Water Leakage

Record the following:

- a. Simulated rainfall rate, in inches per hours.
- b. Time of exposure on each side, in minutes.
- c. Amount of water present in shop interior.
- d. Damage to equipment, tools, stored materials, etc. due to water penetration or moisture contamination.
- e. Location and reason for leakage.

6.3.2.8 Environmental Storage

Record the following after each test:

- a. Temperature, in degrees F.
- b. Relative humidity, in percent
- c. Time of storage, in hours
- d. Time to return to normal operating condition, in hours
- e. Damage or deterioration to the test item components
- f. Performance data as described in paragraph 6.2.2

6.3.2.9 Safety

Record the following:

- a. Data collected as described in the applicable section of MTP 10-2-508.
- b. Deviations from normal safety precautions during operation of the repair shop.
- c. Any special precautions required for operating and maintaining the test item.
- d. Any condition that might present a safety hazard, cause of the hazard, and steps taken to alleviate the hazard.
- e. Need for eye protection (goggles or shields), safety switches, and guards on stationary power tools.
- f. Ground voltages on machine frames, if any.

6.3.2.10 Maintainability and Reliability Evaluation

Record data as described in the applicable sections of MTP 10-2-507.

6.3.2.11 Human Factors Evaluation

Record the following:

- a. Fill in task/item checklists by rating the criteria for each task as satisfactory or unsatisfactory.
- b. For each noise level measurement:
 - 1) Operator station at which measurement is made
 - 2) Noise level in decibels
- c. Adverse effects of noise on personnel, if any.
- d. Comfort of personnel using test item components and assessability of each.
- e. Ease of assembling, dismantling, and transporting the test item.
- f. Comfort of environment, inside the trailer and in the tent attached to it.
- g. Difficulties arising from man-item relationships and actions taken to overcome them.

6.3.2.12 Value Analysis

Record the following:

- a. Non-functional features
- b. Costly features
- c. Nice-to-have features
- d. Possible design eliminations, simplifications, or modifications

6.4 DATA REDUCTION AND PRESENTATION

Data shall be summarized to reveal significant discrepancies between specified and observed performance, and presented in chart, tabular, or graphic form as appropriate.

6.4.1 Preparation

Tabulate the inspection and physical characteristic data. Prepare calibration charts for the AC and DC electrical meters on the dynamotor-welder.

6.4.2 Electrical Tests

6.4.2.1 Continuity Tests

Tabulate any deficiencies in the cabling.

6.4.2.2 Power Requirements

- a. Calculate the current load on each generator coil using the

following formula:

$$\text{Load} = I/\sqrt{3}$$

I = current in one power line

- b. Tabulate the measured data and calculated generator coil loads.
- c. Tabulate the minimum, maximum, average current load of machines individually and collectively.

6.4.2.3 Dynamotor Power Output

- a. Calculate the current load on each dynamotor generator coil using the formula:

$$\text{Load} = I/\sqrt{3}$$

- b. Tabulate the measured data and calculated generator coil loads for minimum, maximum and average current.

6.4.3 Equipment Performance

6.4.3.1 Dynamotor-Welder

- a. Compute the on time of the equipment, T_1 .
- b. Compute the difference in running time meter readings, T_2 .
- c. Compute the running time meter error,

$$E_T = \frac{(T_1 - T_2)}{T_1} (100) \text{ percent}$$

T_1 = computed time.

6.4.3.2 Air compressor

Compute the system pressure gage error,

$$E_P = \frac{(P_1 - P_2)}{P_1} (100) \text{ percent}$$

P_1 = Test gage pressure reading.

P_2 = System gage pressure reading.

6.4.3.3 Other Equipment

Tabulate all other performance data as required.

6.4.4 Compatibility

Summarize the compatibility aspects of the test item as a system.

6.4.5 Electromagnetic Compatibility

Present the data as described in MTP 2-2-613 and note the operating conditions.

6.4.6 Durability

6.4.6.1 Repair Ship Durability Tests

Tabulate the accelerometer readings for each axis of the test item during each test run. Plot a graph which will show shock level as a function of speed before stopping for each axis of the test item. Summarize the damages and degradations in performance due to the durability tests.

6.4.6.2 Machine Durability

Summarize the effect of 8 hours continuous operation on each power operated machine.

6.4.7 Transportability

Tabulate the accelerometer readings for each axis of the test item during transport operations. Plot a graph which will show shock level as a function of speed before stopping or humping speed for each axis of the test item. List the optimum tire pressures for LOTS operations as determined by the test. Summarize the damages and degradations in performance due to the transportability tests.

6.4.8 Cabinet Assembly Water Leakage

Summarize the damages to the equipment due to water penetration or moisture contamination. Indicate the amount of water present in the shop interior and compare with prescribed specifications.

6.4.9 Environmental Storage

Summarize the damages and degradations in performance due to the environmental storage tests.

6.4.10 Safety

Tabulate the safety data and issue a preliminary report in accordance with USATECOM Regulation 385-6.

6.4.11 Maintainability and Reliability Evaluation

Summarize the maintenance data by tabulating all scheduled and corrective maintenance actions, calculating the total number of man hours required for each type of maintenance performed on each component in the repair shop, and tabulating other required comments and observations.

6.4.12 Human Factors Evaluation

Summarize the observations, comments, and suggestions relative to the extent to which human factors criteria have been incorporated into the design of the repair shop. Tabulate the noise measurement data.

6.4.13 Value Analysis

Summarize any observations relative to the elimination of unnecessary features and document evidence that elimination will not adversely affect the technical performance or safety of the repair shops.